
Space Weather Technical Forecast

Issued on Monday, 22 January 2024 at 13:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Notable Earth-directed CME. Moderate Geomagnetic Storm G2 Likely, Chance G3 22-23 Jan. Further M-class flares (R1-R2 radio blackouts) likely, with a slight chance of X-class flares (R3 or greater radio blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as recorded by GOES16, was Moderate over the last 24 hours, with a peak flare of M1.5 at 22/0622UTC and numerous C-class flares from AR3559 in the northeast. This sunspot region is currently assessed as Fki Beta-Gamma, with a possible weak delta forming in the trailing portion. Also of note is AR3561, which has seen an increase in spots recently, and also has a possible weak delta in its southern portion. The six other named regions on the disc are less complex and more stable.

At 21/0015UTC a filament eruption was seen from the northeast disc, immediately southeast of AR3559, accompanied by a coronal dimming. This feature has been modelled and determined most likely to pass behind the track of the Earth in its orbit to no effect, but there is a chance of a glancing blow late on Day 2 (23 Jan). During the evening of 21 Jan some unusual activity was noted in EUV imagery in the southeastern disc, especially on AIA304 which showed a possible ribbon flare near 40-50 East, which can be a footprint for filament lift-offs. A slow CME is evident in coronagraph imagery, directed mainly to the south, with further analysis ongoing to determine if there is an Earth-directed component, although this appears unlikely. A filament lift-off at 22/1000UTC from south-central disc was observed, but preliminary analysis suggests this is unlikely to have a significant Earth-directed component. Other activity in the period was mainly identified with the off-going western limb and the far side.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, have varied slightly over the last 24 hours, between around 370km/s and just over 400km/s. Current speeds are Slightly Elevated, around 410km/s. This appears to be a slow regime between positive polarity coronal holes, with ACE EPAM LEMS now rising - either because of the inbound 20/0840UTC CME, or else because of a CIR leading CH93/+.

The solar wind density was at Background levels and single-figures ppcc, but on a slowly rising trend, while the IMF was weak, varying between 5-7nT. The north-south component varied weakly. The phi angle was mostly positive (away from the Sun).

Geomagnetic activity was Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at Background levels until around 22/0000UTC, but is now slightly elevated and on a rising trend, although it remains below S1 (Minor Storm) at time of writing.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a steady trend. At 22/0001UTC the 24-hour integrated fluence observation was 1.21e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: M-class flares are considered likely, with a slight chance of X-class flares (mainly

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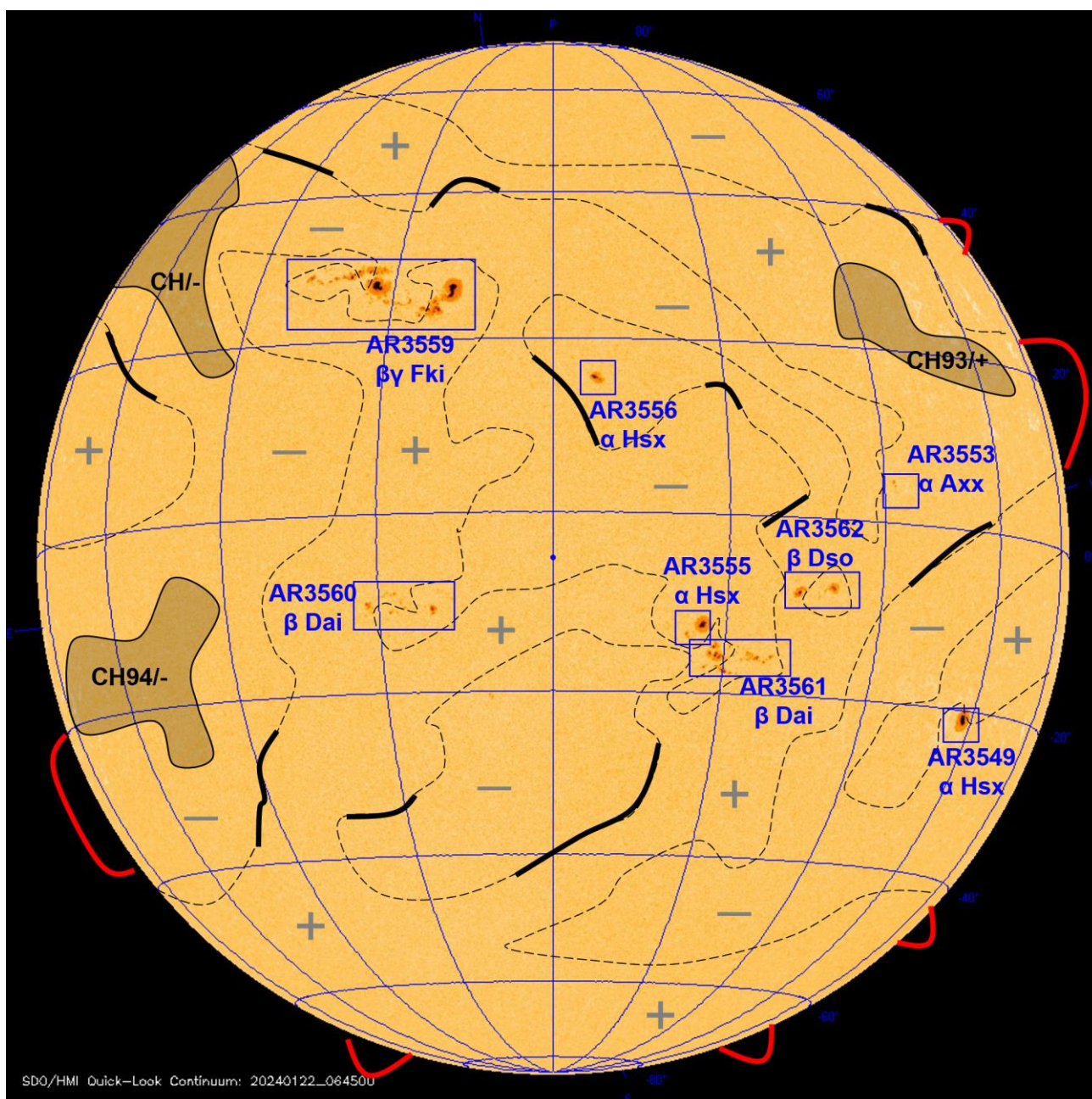
from AR3559).

Solar Wind / Geomagnetic Activity: A near-background solar wind regime is expected until the arrival of the CME from the 20/0840UTC southeast-central filament eruption. A most likely arrival time of 22/1800UTC is suggested, with G2 Likely and with a Chance of G3, continuing into the first half of Day 2 (23 Jan) before likely abating to Quiet conditions by midweek UTC. At the time of writing, a G3 Watch is valid for 22/1200-23/1200UTC.

Energetic Particles / Solar Radiation: High energy proton flux is likely to breach the S1 (Minor Storm) threshold ahead of the expected CME arrival on Day 1 (22 Jan) before waning later Day 2 (23 Jan).

The high energy electron flux is expected to continue at Normal Background levels initially, with any fast wind from CH93 and an inbound CME significantly increasing uncertainty, with a resulting very slight chance of Active 24-hour integrated fluence as a result on and after Day 3 (24 Jan).

Figure 1. Solar Analysis Valid 22/0645UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

The dominant consideration for geomagnetic activity is the large filament eruption from the southeast-central disc starting 20/0840UTC. While MOSWOC Enlil modelling suggests an arrival time of this CME front at Earth of 22/1500UTC, this has been delayed slightly due to Enlil's ongoing 500km/s fast wind that has not been observed in reality. Arrival is therefore suggested at 22/1800UTC.

At 21/0015UTC a filament eruption was seen from the northeast disc, immediately southeast of AR3559, accompanied by a coronal dimming. This feature has been modelled and determined most likely to pass behind the track of the Earth in its orbit to no effect, but there is a chance of a glancing blow late on Day 2 (23 Jan). Further filament eruptions observed on 21 and 22 Jan are considered unlikely to give significant geomagnetic response.

Earth is otherwise currently sampling a sector of space characterised by a positive phi angle and a minor enhancement to the solar wind. This may be the tail of CH92/+, however this is uncertain and in any case has not led to significant geomagnetic activity. There may remain one fast wind due imminently - that from CH93/+, however this too is now overdue (if not already in course). Expected speeds and resultant geomagnetic activity are now perhaps 400km/s and Active intervals at most. As for an arrival time, the low energy proton spectrum at ACE EPAM LEMS is showing a gradual rise, which could either be a CIR leading this fast wind, or else an early response to the inbound 20/0840UTC CME.

G2 Moderate Geomagnetic Storm is Likely on Monday 22 January (with G1 or G2 Expected), with an accompanying Chance of Strong Geomagnetic Storm (G3) at peak. At the time of writing, a G3 Watch is in force for 22/1200-23/1200UTC. The risk of G2 should then ebb into the first half of Day 2 (23rd Jan), with conditions reverting to Quiet Day 3 and Day 4 unless further strong flares occur.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	80	50	5	1
Strong	G3	No	30	10	1	1
Severe	G4	No	5	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/1302	Partial	Filament	SE centre disc	953km/s	22/1800UTC	Low confidence arrival time.

Radio Blackouts - X-Ray Flares:

The Penticton 10.7cm flux saw a sharp rise from 166sfu to 179 between the UTC weekend days, mainly tied to the development of AR3559 in the northeast quadrant.

The bulk of the daily risk sits with the regions already visible, especially AR3559 and AR3561. No significant sunspot regions leave the disc in the four days, and the chances of M-class flares are therefore held at Likely throughout - near the raw risk values for the Zurich classes of the disc's sunspot regions. There is a slight chance of isolated X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	15	15	15	15

Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently slightly elevated and on a rising trend, ahead of the expected CME arrival later today. It is likely it will breach the S1 threshold in the next few hours, and should decrease again on Day 2 (23rd) as we enter the CME magnetic cloud.

Beyond Day 2 (23rd) there is a daily Slight Chance of reaching the S1 Minor Radiation Storm threshold in response to any notable flares, with this rising slightly as the more complex regions of the facing side near more favourably-connecting parts of the disc.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	60	60	15	20
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event ($\geq 2\text{MeV}$):

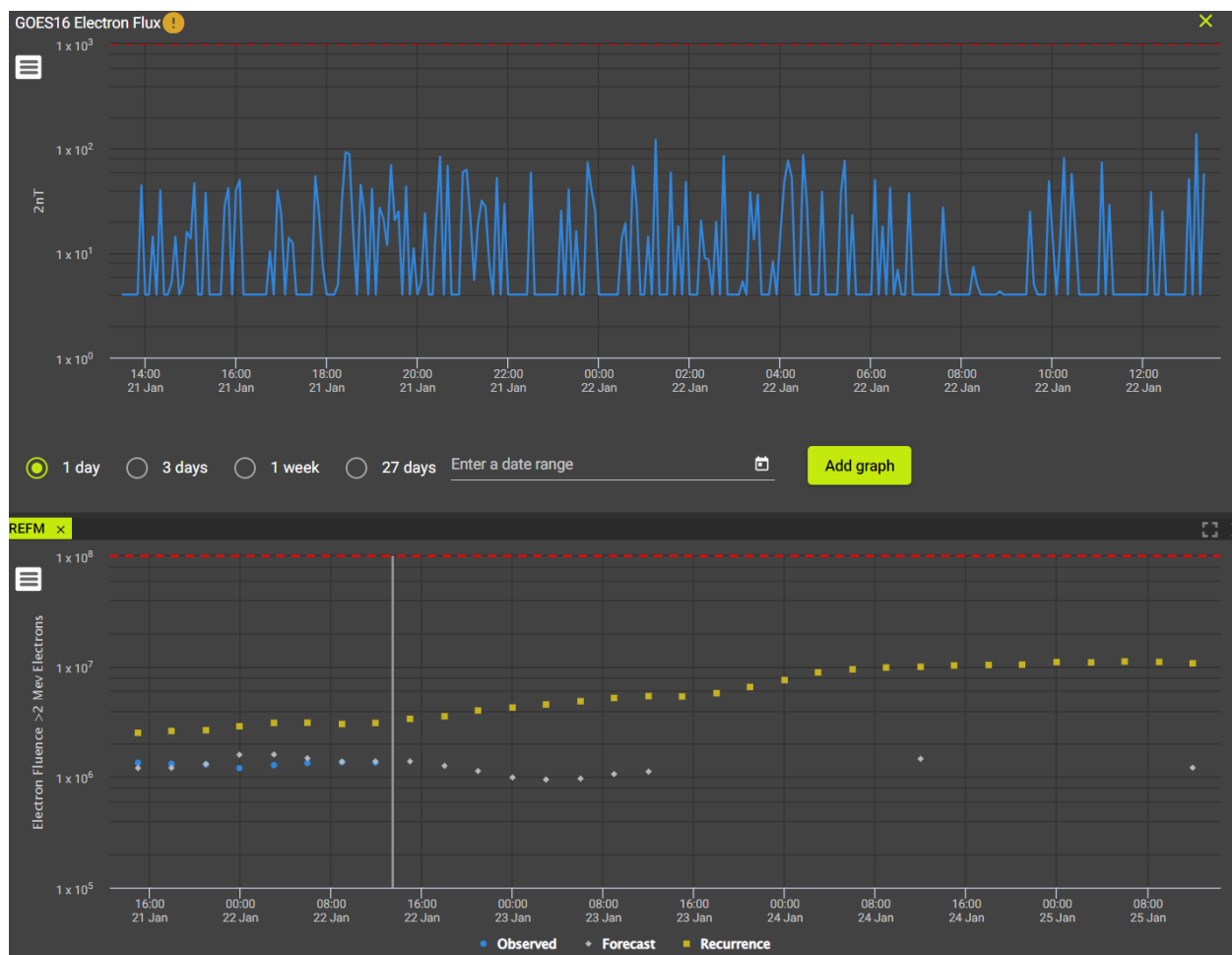
High energy electron flux (greater than 2MeV) is at Normal Background levels.

The only fast wind (CH93/+) that was due to arrive in the period is now either overdue or not impactful, so an electron response now looks less likely. The inbound CME from 20 Jan will render GEO electron behaviour relatively low confidence, but there remains a very slight chance of Active 24-hour integrated fluence at the end of the period.

MOSWOC REFM is not expected to provide a useful steer given the dominance of a transient in the forecast.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	5	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 2: GOES16 >2MeV Electron Flux (top) and MOSWOC REFM and recurrence (bottom)



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